CHAPTER 15

INDUSTRIAL WATER SUPPLY SYSTEMS

15-1. Industrial water supply system design features

This chapter presents an overview of industrial cooling systems and their various components. The industrial cooling system is the means by which heat generated by facility equipment (diesel engines, thermal storage refrigeration, and chillers, typically) is removed from the facility. Under normal operating conditions, this heat will be rejected to the outside by cooling towers and the condenser water piping system. When the cooling towers are not operating, this condenser water is circulated through the industrial cooling system and reservoir(s). Each industrial cooling water system is designed to transfer heat by the most efficient and reliable method. While there is no right way to design an industrial cooling system, all industrial cooling water systems have common characteristics and use common types of components.

a. Terminology. For the purposes of this manual, the term "industrial cooling system" refers to any heat removal system that uses a body of water as a heat sink. A condenser water system refers to a system that removes heat with cooling towers. There may be some confusion in the use of this terminology because some facilities refer to an industrial cooling water system as that which removes heat with both cooling towers and a heat sink (industrial reservoir). A condenser water system and an industrial cooling system both serve the same function, heat removal. In addition, these two systems share much of the same piping, valves, and additional system components.

b. System functions. Industrial cooling is used in the event of failure of the normal condenser water system, or if cooling towers are to handle the facility head load. The system may also be used during a variety of operating scenarios including testing, blowdown of the condenser water system, maintenance, crew training, load shedding, or blast conditioning. The primary function of the industrial cooling system is to serve as a backup for the condenser water system. The condenser water gains heat as it is circulated through the facility equipment (chiller condensers, diesel engine jacket water heat exchangers, diesel engine lubricating oil heat exchangers, thermal storage refrigeration units, etc.). This warm condenser water then travels through the cooling towers, giving up the heat it gained, and is pumped through the circuit again by the condenser water pumps.

c. Reservoir water supply. The reservoir water supply system has the function of providing industrial water to each facility for storage in the industrial reservoirs. Water is supplied to the reservoirs by one of two ways. One method is by water wells located on or outside of the facility. The second method is by pumping stations that deliver the water into the facility from an external water treatment or monitoring facility. With either method, the pumps can be controlled locally or from a remote control station, and they can be manually started or operated automatically by a level controller located at the reservoir. Another source of water to the industrial reservoir may be underground spring water.

d. Reservoir cooling system. During industrial reservoir cooling, the cooling towers and condenser water pumps are turned off, reservoir pumps are activated, and control valves are positioned to divert water around the towers and pumps. The warm condenser water (now referred to as industrial water) is delivered to the industrial reservoir. As the returned industrial water makes its way through the reservoir to the reservoir pump suction, the reservoir acts as a heat sink by dissipating the heat gained by the industrial cooling water. The heat capacity of the industrial reservoir is dependent on facility cooling and electrical loads, and volume of water in the reservoir. When industrial reservoir cooling has been operating for an extended period of time, the industrial reservoir will lose its ability to dissipate heat from the returned industrial water. This occurs when the reservoir reaches a certain temperature. At that temperature, reservoir dump is begun. Reservoir dump is simply the removal of the hot reservoir water from the facility.

e. Makeup water system. The industrial cooling system requires makeup water at all expansion tanks. The makeup water system replaces water lost in the condenser water or industrial water systems. As pressure in the expansion tank decreases, the makeup water valve will open allowing makeup water to enter the system until the pressure increases to a point above the setting of the makeup water valve. Makeup water does not apply to the industrial reservoirs, since water is continuously supplied to the reservoir based on the water level in the reservoir. As the water level in the reservoir falls, the water level controller will automatically activate the supply pumps to replenish any water lost from the reservoir.

f. Water treatment. Water treatment consists of maintaining approximately 1 ppm (part per million) residual chlorine in the industrial reservoir of the industrial cooling system. A hypochlorinator unit is used to inject chlorine into the reservoir piping system. The industrial reservoir water should be checked (tested) daily to determine whether chlorine is needed. If the reservoir residual chlorine is in excess, reservoir water should be drained while adding fresh water from the supply system until the residual chlorine is approximately 1 ppm. This should only be done during normal operating conditions. Additional water treatment may be required at the cooling towers and for the condenser water system.

15-2. Industrial water supply system major components

Industrial water supply systems are generally comprised of the following major components.

a. Reservoirs. Water storage reservoirs are used for both domestic water and industrial cooling. The reservoirs are unlined rock chambers that extend, mostly horizontal and slightly down, from a common audit area. The reservoirs may include a steel bulkhead or concrete dam in front to retain the water within the reservoir. In addition, the reservoir may include a pump platform, located above the water level, from which the reservoir water is drawn by the distribution pumps.

b. Tanks. Surge tanks are used in the reservoir water supply system to absorb water surging or water hammer shock in the industrial water supply line between the reservoir and the supply pumps. The tank is a closed tank pressurized with compressed air which absorbs the water surges caused by starting and stopping of pumps. A liquid level control maintains a constant air pressure in the tank by modulating an air supply valve. Expansion tanks are used in industrial cooling (condenser) water systems to allow for thermal expansion and to provide a location for makeup water to be admitted to the system.

c. Wells. Wells extract water from permeable water bearing layers called aquifers. The wells used for industrial water supply systems typically have an 8- or 6-inch casing which fills with water. A pump forces the water up to the surface.

d. Pumps. For an expanded discussion of pumps which can be used in industrial water systems, see chapter 11.

e. Control valves. Control valves are used in condenser/industrial water systems to control the flow of water through the piping system. The control system positions the valve through a valve operator or actuator that is directly attached to the valve stem. Control valves must be carefully sized and selected for the particular design conditions. Control valves used in condenser/industrial water are typically equipped with a throttling plug or V-port that is specially designed to provide the desired flow characteristics.

f. Valves. For a discussion of the types of valves which may be used in industrial water systems, see chapter 11.

g. Strainers. Strainers are defined as a closed vessel with cleanable screen element designed to remove and retain foreign particles down to 0.001 inch diameter from various flow fluids. A strainer differs from a filter in that strainers trap particles that are typically visible to the naked eye. Strainers are typically installed in condenser water systems on the inlet (suction) side of the distribution pumps.

h. Piping. Pipe used in industrial/condenser water systems for sizes 2 inch and smaller is typically standard weight, continuous weld steel pipe with threaded joints and cast iron fittings. For industrial/condenser water piping larger than 2 inches, steel pipe conforming to American Society for Testing and Materials (ASTM) A 53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless (1999), is used. Joint types for this size of pipe are either welded, flanged, or grooved. Fittings for A 53 type pipe are wrought steel, cast iron, and malleable or ductile iron.

15-3. Testing

The industrial reservoir(s) plays a critical role in the success of a given facility's mission. Because the industrial water system is required to be operational before the systems it supports can operate, it is probably the most important system in the facility. Due to this fact, the reservoir should be placed through a series of tests periodically to provide reassurance that the industrial reservoir maintains a high level of reliability and will perform adequately when needed. The following items should be considered when developing a testing procedure for the industrial reservoir.

a. Record information. Prior to beginning any test on the industrial reservoir, always record the following information: the reservoir water temperature, the water level or the amount of water in the reservoir, individual condenser water flow rates through all equipment, entering and leaving temperatures of condenser water through all equipment, total condenser water flow to the cooling towers, and condenser water supply temperature to and return temperature from the cooing towers. Always record the date and exact time the test was begun. In addition, record the time any significant changes occur in flow rates and temperatures in the system, along with this new data. Always record the ending time of the test.

b. Manual switchover. The ability of the condenser water system to switch to industrial reservoir cooling should be tested manually by opening/closing valves locally, and starting and stopping the appropriate condenser water and industrial reservoir pumps, also from local control stations. Personnel should be assigned specific tasks and timed as to how long is required for manually switching the entire condenser water system over to industrial reservoir cooling.

c. Remote switchover. The ability of the condenser water system to switch to industrial reservoir cooling by initiating reservoir cooling from a central control room should be tested.

d. Automatic switchover. The ability of the condenser water system to switch to industrial reservoir cooling automatically by simulating a blast as detected from the blast sensors should be tested.

e. Temperature. Once industrial reservoir cooling is initiated, the temperature of the reservoir should be monitored and recorded at regular time intervals until the completion of the test. In addition, the flow rate into and out of the reservoir should be continuously monitored and recorded, again until the test is completed.

f. Reservoir dump. If reservoir dump is initiated, the starting time, flow rate, temperature of reservoir water, and stopping time should be recorded.

g. Fresh water. If fresh water is added to the reservoir during testing, the following should be recorded: the supply water temperature to the reservoir, the exact starting time that water is supplied, the flow rate of water to the reservoir, the temperature of the reservoir when the water was added, the temperature of the reservoir when the supply to the reservoir stopped, and the exact time when the supply to the reservoir stopped.